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Science Council of Canada

April 1972

General publications

Issues in Canadian Science Policy

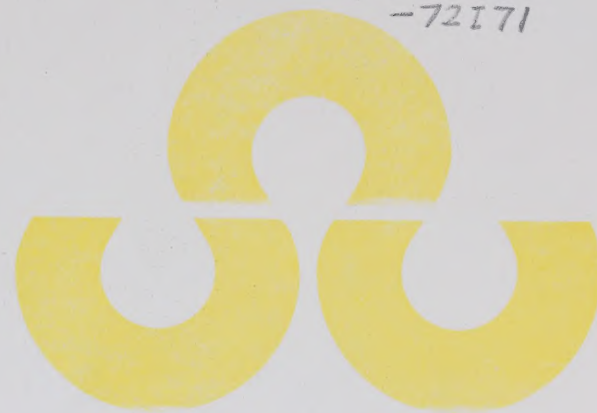
A commentary on some
aspects of Vol. 2 of the
Report of the Senate Committee
on Science Policy.

NOTE: The text of this commentary will reappear,
in printed form, as part of the
Sixth Annual Report of the Science Council.

NOT TO BE RELEASED

UNTIL MAY 10 1972 3:00 P.M.

Science Council
of Canada
Conseil des Sciences
du Canada
150 Kent Street
7th Floor
Ottawa 4



Office of the Chairman/Cabinet du président

April 26, 1972.

The Hon. Alastair Gillespie, P.C., M.P.,
Minister of State for Science and
Technology,
House of Commons,
Ottawa, Ontario.

Dear Mr. Minister,

On January 18th of this year, there was published Volume 2 of the Report of the Senate Committee on Science Policy, a document which ranged over a wide spectrum of issues of current concern in Canadian Science Policy and one which presented the Federal Government with a set of some 45 specific recommendations, many of which would have far-reaching repercussions for Canadian science.

The Science Council has given careful and detailed consideration to the Senators' proposals and to the philosophy which underlies them, and has concluded that it would be appropriate to make public our commentary on the aspects of Volume 2 which we consider to be most important. In this statement we have tried to delineate those areas in which there is general agreement between the Senators and ourselves; in those areas where differences of opinion remain, it is our hope that our commentary will stimulate further informed discussion.

Yours sincerely,

Omond Solandt

O.M. Solandt

ISSUES IN CANADIAN SCIENCE POLICY

INTRODUCTION

Two events occurred in the last year which are of considerable significance to the future of Canadian Science Policy. One was the establishment of a Ministry of State for Science and Technology, charged with developing a science policy for Canada; the other was the publication of Volume 2 of the report from the Senate Special Committee on Science Policy, "Targets and Strategies for the Seventies". That volume presents the Senate Committee's views on the general background and framework for science policy development; further, it makes 45 specific recommendations - some of them calling for considerable organizational changes - to reform what is seen by the Committee as the present "accidental" science policy.

When he first proposed the establishment of the Special Committee on Science Policy, Senator Lamontagne, the Committee Chairman, remarked that

"If, at the end of our hearings and discussions, a realistic but imaginative report is issued, this could mark the beginning of a radical reform of the structure of our central government, which is so urgently needed if that government is to fulfill adequately the important tasks required by the new emerging society."

(Senate Hansard, June 29, 1967, p. 254)

It is, of course, much too early to assess the impact of Volume 2 of the Senators' Report, and of its many recommendations; nevertheless, what it has already achieved is the status of an important and much needed catalyst of public debate on the issues of Canadian Science Policy.

For the last six years the Science Council has been at work on the same topic. Its conclusions and recommendations have appeared in the form of eighteen Council reports, supported by twenty-two background studies. This is clearly an opportune time to sum up the main lines of our argument, and to elaborate on them in terms of the Senate Committee's framework for science policy.

It is to be expected that the conclusions of the Senate Committee and of the Science Council will, in places, be divergent since the perspective from which the two bodies view science policy is so different. The Senators have wide experience in the political arena where public policies meet the ultimate test, but they view science and the scientific community as external observers; we, as members of Science Council, have an internal view of the conduct and management of scientific activities which we now seek to portray against the broader backcloth of public policy. What is gratifying is the way in which many of the goals identified by the two bodies coincide; what remains is the need to stimulate informed public debate on the means which Canada might best adopt to attain these goals.

Both the Senators and Science Council are convinced of the importance of the impact of science and technology on our society and of the need to seek understanding of the changes -- both for the better and for the worse -- which man's use of science and technology has wrought on our lives. We are pleased to see the Senators' forthright and explicit recognition of the value of basic research, and of basic researchers, to the life of our country. Their recognition of the great importance of innovation, particularly at present in our manufacturing industries, adds support to views which we have already published. Both of our groups have become convinced that strenuous efforts are needed to strengthen our scientific and technological efforts in the non-governmental sector of our economy, and we recognize the magnitude of the many serious impediments in the way. A major feature of any attempt to strengthen our overall performance must be a substantial upgrading of our management and planning skills. Finally we all share the concern for both the quality and relevance of the extensive activities in science and technology which Canada supports.

What follows is an attempt by the Science Council to set out the principal areas in which the views of the Council and of the Senate Committee appear to diverge, our aim being to stimulate discussion and to clarify the issues. In some cases the divergence is real and reflects the contrast between the internal and external views of how science works; in others the divergence may turn out to be more apparent than real since our interpretation of the Senators' text may not always fully coincide with the meaning which was intended.

The most profound divergence concerns the purpose of science and technology. The Senators' view of this purpose has implicit within it the danger that science and technology may come to be regarded as goals in themselves. In our view, science and technology are tools to achieve human and national objectives. This, it seems to us, is the basis for science policy. As a consequence, we have argued against the concept of establishing a target for national R & D expenditure, as a percentage of GNP or any other index. Rather, we argue, as much - or as little - R & D should be performed as our national goals require. Related to the concept of a target national expenditure is the concept of a "coherent" science policy. Attractive as this sounds, it disregards the basic fact that different regions and different social and economic sectors have different priorities. Canada has need of a multiplicity of science policies. The Science Council believes that coherence in science policy is more to be striven for than imposed from above, and that a combination of compatible sectoral policies is a more realistic aim.

Secondly, the Council seriously questions the desirability of separating basic and applied research - in its performance, funding, administration, and communication. This is, we feel, a retrograde step, and runs counter to the whole weight of evidence on the advantages of interaction. We question, too, the proposal to centralize most governmental science and technology in a few agencies, leaving the rest, particularly the line departments, with substantially diminished scientific competence. Canada's real need is to redirect those departmental programs which are no longer squarely oriented towards their missions.

Finally, the Science Council supports the Committee's stand on the importance of industrial innovation, but has misgivings about the means it proposes, especially if, as the text implies, the proposals are to apply only to R & D. Industrial innovation comprises a whole range of activities, from original conception of new goods or services to their acceptance in use by the consumer. R & D is frequently the least expensive link in this chain. A policy of increasing industrial R & D five-fold in the next eight years - without considering the adequacy, funding and managerial aspects of all the other links - would fail to meet the objective, which we share with the Senators, of increasing the total innovative capability of our industries. Pushing on the innovative chain from the R & D end is not nearly as practical or rewarding as pulling on it from the market end.

The Senate Committee seems, in its emphasis on secondary manufacturing industry, to give inadequate weight to the changing shape of our economy. While the whole service sector of our economy now employs about 60% of our labour force, the private service sector alone employs about as many Canadians as do the manufacturing and primary resource industries together, and is growing far more rapidly. Innovation in this sector is as badly needed as in manufacturing. The Report errs, too, in regarding our universities largely as training centres for R & D in manufacturing industry; in fact, in this decade the talents of our graduates will mainly be required elsewhere.

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These are three fundamental points where our opinions and judgment differ from those of the Senate Committee. In what follows we recapitulate the evidence on which the Science Council's judgment is based.

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Finally, the Senate Committee suggests the Committee's stand on the importance of industrial innovation, but has nothing to say about the need to promote, especially in the case of the small business, the growth of to-day only in the U.S. Industrial innovation requires a whole range of activities, from original conception of new goods or services to their acceptance in use by the consumer. It is to be frequently the least expensive link in this chain. A policy of increasing industrial R & D three-fold in the next eight years - without regard to the economy, funding and managerial aspects of all the other fields - would still be near the objective which we share with the Senators, of increasing the total innovative capability of our industries. Focusing on the innovative effort from now on, it is not nearly as practical or reasonable as building on it from the outset and

The Senate Committee seems, in its emphasis on secondary manufacturing industry, to give inadequate weight to the changing shape of our economy. While the whole service sector of our business has grown about 60% of our labor force, the private service sector alone employs about as many Canadians as do the manufacturing and primary resource industries together, and is growing far more rapidly. Investment in this sector is as badly needed as in manufacturing. The present bill, too, is restricted by universities largely as existing centers for R & D in manufacturing industry; in fact, it is not nearly as practical or reasonable as building on it from the outset and

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These are the questions which the Senate Committee has asked. The evidence on which the Senate Committee's judgment is based.

A "COHERENT" SCIENCE POLICY

The Science Council, in considering the relation of science policy to the goals of the Canadian society, has concluded that science and technology should be considered as tools in the service of those goals, rather than as goals in themselves. Given this concept, then, the decisions that determine how much should be spent on R & D are properly made in the first instance by those agencies, whether in the public or private sector, that exist to work towards the various goals, whether social, economic or cultural. It is they who must decide how cost-effective are the potential opportunities offered by R & D in comparison with the other means open to them of achieving their purposes. While R & D may often offer the key to a solution, this need not always be so; for example, the bottleneck to improved urban design may not be technological (see Science Council Report No. 14). A cardinal rule is that an industry should not be enticed into performing R & D for which it feels no need or which it is in no position to exploit. (On the other hand, a government department should never have all of its scientific competence stripped away, leaving it ill-equipped to be an intelligent user of the research services which industry and the universities can offer.)

A central ministry, such as we now have in the federal Ministry of State for Science and Technology, can have a useful and important "horizontal" function, in coordinating scientific activities throughout the government agencies. It can assist cross-fertilization, it can reduce outright duplication, it can help initiate new programs, particularly serving new needs or opportunities that may go unnoticed because they fall between established missions. And it can strive for consistency of policies, in employment practices, in contracting out, and in assuring the continuity of support that good scientific work needs.

Such a ministry could also develop some criteria or rules of thumb by which to assist Treasury in assessing whether one agency or another may be making inadequate, or excessive, demands for research funds in its budget. And such a ministry should undoubtedly adopt a "conservationist" policy with regard to the resources of highly qualified manpower, looking ahead to assure an appropriate supply insofar as needs can be anticipated, and trying to coordinate the programs of government agencies so that declining requirements in one may be to a reasonable extent balanced by rising requirements in another,

But all of this is a far cry from making a target or goal of a certain level of expenditure on R & D, as the Senate Committee recommends. The Science Council put itself on record in Report No. 4, (1968) saying that it

"... does not believe that there exists any particular proportion of the Gross National Product which, a priori, should always be allocated to R & D. Canada should not fall into the trap of allocating this or that percentage of GNP to R & D and then dividing up this "budget for R & D" between the contenders for funds. The funds which are allocated to scientific activities annually should be granted,

program by program, in face of competition from other potential users of these funds, with each program justifying its expenditures on economic, social or cultural grounds. The 'R & D budget' would then become the sum of the allocations of funds to individual programs and activities."

The Council still stands by that opinion, and therefore finds itself in disagreement with the Senate Committee on this quite fundamental point. By way of explaining the Council's position further, it revolves around the distinction between a target and an indicator. The "sum of the allocations of funds to individual programs and activities" can serve, in the Science Council's view, as a useful indicator. Some might even interpret the level of R & D as an index of innovative liveliness. Or, for example, in an area where decisions are so much a matter of judgment, decision-makers like to check their judgments against the judgment of others from time to time; they take comfort in finding they have company in their extravagance, or their conservatism, as the case may be. But the wise decision-maker does not ape the other's behaviour as his starting point or goal. The distinction may seem subtle but has important consequences for policy in practice.

THE ORGANIZATION OF RESEARCH

The subject of free basic research (where the scientist is left free to follow where his interest leads him) has always seemed a contentious one. Almost by definition it cannot be subject to policy, save for some decision about the total amount of public funds that should be directed to the activity. The most conceptually convenient procedure is to regard it as a category apart, as the Senate Committee has done, with its support justified on cultural grounds. Yet, to do so is to take no account of its secondary benefits, to teaching, to scholarship, and to all the more directed gradations of scientific research effort. When secondary benefits are recognized a number of consequences follow. First, the level of financial support is likely to be higher than on cultural grounds alone. Second, it is appropriate to locate the work in establishments where other activities, such as oriented basic research, applied research, and teaching are going on, rather than isolating it in a separate world. Indeed, many "pure scientists" prefer it that way. Like Isaac Newton, their deep insights and unflagging curiosity do not prevent them from also being interested in the world of practical affairs, and they often elect, of their own free will, to turn their minds to some of its problems. Frequently a scientist may be engaged simultaneously, or alternately, in both basic and applied research.

The Science Council has consistently emphasized the importance of basic scientific research in relation to the practical missions of government agencies. Not only is this important for improving the basis of knowledge relevant to the missions in the longer term, but the basic researchers bring with them a standard of quality of work, and a depth of understanding of current knowledge in the relevant fields that can greatly inform and improve the work of the scientists and engineers engaged on problems of more immediate

and limited scope (applied science). For this to happen the laboratories and the working groups must be organized in such a way that frequent and informal contacts occur among the people working at different levels of generality; it is by these informal and verbal interchanges that genuine communication is achieved across these "vertical" interfaces, as, for example, between basic and applied research or between applied research and engineering design or development. Something vital is lost if the organization comes to depend on interaction only through formal meetings and written reports. Yet it is also true that the basic scientist requires a considerable degree of independence and isolation from day-to-day problems if he is to do his best work. Organizing for the optimum compromise is one of the central problems for research management anywhere, in government or in industry.

The Science Council agrees with the Senate Committee when it notes that, through much of history, science and technology can be regarded as having progressed in two almost separate but interacting streams. Thus at the two extremes, basic scientists and empirical technologists often seem to live in two completely different motivational worlds. However, the historical trend seems to be that the two streams have been converging, particularly rapidly in the last few decades. Furthermore, it is precisely because of this tendency of groups to fragment into different motivational worlds, and thus to break communication lines at the interfaces where motivations shift, that management must be careful as much as possible not to interpose additional barriers at those interfaces in the form of organizational divisions or geographical separations.

One of the characteristics of basic science is an open and well-developed internal communication system, in the form of the scientific literature and regular scientific meetings. This makes it possible for basic scientists to work relatively effectively even though widely scattered in small groups. Thus, where separations must be introduced, for administrative or other reasons, it will often be easiest and will do least harm to the dynamics of the interactions to separate groups of basic scientists one from another than to interpose barriers along the other dimension of basic/applied or research/development. The aggregate categories of interest to statisticians or budget analysts do not necessarily correspond with the structure or dynamics of effective working organizations. Again, however, compromises are necessary; even basic scientists should not be so fragmented that their groupings drop below critical synergistic size, or that they require excessive duplication of expensive facilities. The Science Council has set out its views in greater detail on these principles related to basic science in Report No. 18, "Some Policy Objectives for Basic Research in Canada".

With these thoughts in mind, we would like to comment on two of the Senate Committee's principal recommendations on government organization -- those which propose that "most basic research activities of the Canadian government be concentrated in a national research academy..." and that "[Industrial] laboratories operated by government departments and agencies for

secondary and service industries as well as for mining and power utilities] "be brought together in a new Crown company called the Canadian Industrial Laboratories Corporation". We feel that the underlying objective sought by the Senate Committee is close to what we had in mind when we said, in Science Council Report No. 4, that "A major past failing in Canadian science has been the performance of too much basic research remote from the training of new scientists and the performance of too much applied research far from the point of innovation." What the Science Council would like to see achieved would be the establishment of much closer links between government laboratories and the laboratories in universities and industry, but links which would not disrupt the communication system from basic research to applied research and development, and which would also leave enough scientific competence within the departments and agencies to permit them to intelligently pursue their missions.

The real deficiency in some departmental programs, as we noted in our Report No. 4, lies in their tendency to stray from their mission and to drift into research termed basic simply because the sense of application has been lost. The cure for this, in our opinion, will not come from a simple pruning of irrelevant research programs but rather from better direction and management of the entire program and from a reinstitution of a sense of mission. If this is achieved, then the internal management of the program should quickly dispose of any superfluous "basic" research.

Some government laboratories, such as AECL and NRC, have long experience in the management of both basic and applied research, and have developed fairly effective internal interrelationships. The Science Council has been critical of the National Research Council in the past, principally because it was felt that some of its applied research had been losing its relevance and sense of purpose -- the freedom of program choice essential to the free basic research component had been excessively extended to include applied research and even development in many parts of the organization. NRC has since taken some steps to remedy the situation, forming a planning secretariat (program planning and analysis group), and seeking to improve its industrial relationships. As we stated before, improved links between government and industrial laboratories are much needed. NRC has taken the first steps along the long road to achieving this goal.

Most members of the Science Council would generally agree with the Senate Committee's recommendations that NRC's university-research granting function should be separated from the laboratory function (although we have reservations, expressed later, about the Senators' proposed Foundations), and that the Minister of Industry, Trade and Commerce be designated as the Minister to whom the laboratories report, but we are opposed to the proposal that would, in effect, confine all of NRC's basic researchers within a National Academy thus divorcing those involved in mission-oriented basic research from the mission they are seeking to serve, and transfer the rest of its activities to an industrially-oriented Crown corporation. There are many problems in our society that need attention besides those in private industry. Further, NRC will probably continue to be most effectively used

in a balance-wheel, gap-filling, and program initiating function in relation to government departments, rather than taking over departmental activities into a massive integrated research organization. Let us not forget the effective and rational way in which programs like atomic energy, and defence research, were initiated under the NRC umbrella - and then hived off when they were large enough to stand on their own. The NRC, as it evolves, could well play such a role again in initiating some of the major program approaches suggested by the Science Council in Report No. 4 and in subsequent publications.

The Science Council remains convinced of the validity of the concept of "Major Programs"* as an important vehicle for channelling scientific and technical resources towards the solution of significant, defined problems. The Senate Committee, in rejecting the Major Program approach, except in some areas where the market is defined by the public sector, as being too risky a strategy for Canada, seem to confuse major programs with major inventions; their presupposition that "when they (major programs) fail they are likely to be national catastrophes" reflects a considerable misunderstanding of the concept and a lack of the very entrepreneurial nerve, on the part of the Committee, which they rightly argue that Canadians must develop. We agree with the Committee's concern that the need for such programs must be firmly established at the outset and we would add that once started the programs should be carried through to completion, not abandoned at some incomplete stage; it is our judgment that many needs which would justify such ventures do exist.

On the organization of the granting councils** the Science Council previously stated (Report No. 5, "University Research and the Federal Government"):

"The needs of the 'in-between' disciplines and the growing importance of interdisciplinary research make it essential that the activities of the granting agencies be very well coordinated. Because of this, many believe that the most appropriate mechanism would be a single granting council separated into three or more strong and relatively independent committees representing the major branches of knowledge. However, we have three well-established institutions serving us in this function and it would be unwise to attempt such a fundamental reorganization at this time. The Science Council believes that the immediate needs of university research in Canada will be better served by making the necessary modifications to the existing system than by creating a new agency or agencies."

* See Report No. 4, October 1968

** Currently the National Research Council, the Medical Research Council and the Canada Council

Thus, while the Council's position expressed at that time (1969) was in sympathy with the aims of the Senate Committee expressed recently, the Council preferred an evolutionary approach. The upshot was the creation of the Tri-Council Coordinating Committee, to coordinate the granting policies of the NRC, the MRC, and the Canada Council. The decision to integrate the Councils at this time into a single organization reporting to the Secretary of State, as recommended by the Senate Committee, could be taken by the Government as a matter of administrative convenience if it should see fit. The Science Council would not take a strong position on the matter. However, there are certain features of the Senate Committee recommendations which in the Science Council's view should be rejected.

First, the concept of restricting the Board to funding only free basic research is impractical. It would lead to endless and useless arguments on the classification of projects as basic or applied, free or oriented. It would represent a retrograde step from the growing tendencies to diffuse the attitudinal differences between free, oriented, and applied research. While permitting transdisciplinary projects, it would impede the development of university research which was self-oriented (i.e., curiosity-motivated and ethically-motivated) toward local and regional problems requiring integration of basic, applied and developmental activities. In recommending that the Medical Research Council be subsumed under the Life Sciences Foundation, they would include a body that at present has a strong orientation toward problems, many of them applied, affecting human health. Since the bulk of Canada's medical research is performed in university faculties, any restriction of the funding of that research to the basic end of the spectrum would place the existing applied programs in jeopardy.

Secondly, the Senate Committee argues that the granting organizations should not exert any guidance on the directions of research, yet they are not quite consistent on the matter. In recommending that the Foundations "assist only those (projects) that are relevant to the Canadian scene" the Senators imply considerable direction of the research supported. The position of the Science Council has consistently been (Report No. 5, p. 11):

"Macdonald and his committee* have suggested that the granting councils should play an entirely passive role in providing support for university research. They see the councils as responding to proposals originating from universities and awarding their support purely on the basis of whether or not the proposal represents 'good research'."

"The Science Council believes that this basis alone is not sufficient and that, in addition, the granting councils must play an important role in giving broad guidance to the direction to be taken by university research. In

* See Special Study No. 7 "The Role of the Federal Government in Support of Research in Canadian Universities" by J.B. Macdonald et al., 1969.

other words, the granting councils must always be able to support good research which is purely interest-motivated but also they must be willing and able to stimulate research activity in important areas where development is lagging."

"The areas of research pursued by universities and the fields of training of their advanced degree graduates are not the concern of universities alone; they are also the concern of the nation. We do not believe that the sum of the policies of individual university researchers necessarily provides the best policy for the nation."

INNOVATION

The reason for the Science Council's concern with innovation is simply that new or improved goods and services can make Canada a more rewarding place to live. Many of these innovations should take place in Canada - rather than being imported - for equally simple reasons: they provide personally fulfilling employment opportunities for an increasingly well-educated population; and many of our problems, geographic and climatic, are peculiarly Canadian.

The secondary reasons outlined in the Council's Report No. 15 are equally pragmatic: employment of a rapidly-growing labour force; lessening our dependence on non-renewable resources; maintaining our position in world trade - we are a trading nation; and ensuring the survival of our industrial sector - whose taxes are needed for the common good.

These are, we believe, valid enough concerns; it is however over-restrictive to confine innovation to the role of increasing our economic growth rate, as the Senate Committee appears to do in Volume 2. Nor should we make innovation a national objective in its own right, as Volume 2 recommends; like science and technology, it is simply a means to an end. We do not need to compete in every event in the International Technological Race; rather we should be specialists.

One way of making informed choices is through the Major Program concept outlined in the Council's Report No. 4. These programs should be based on Canada's perceived national objectives, and contain intermediate-size projects which will stimulate certain existing industries and create other totally new industries in Canada. In contrast, the Senate Committee gives a blanket endorsement to all forms of innovation in all categories of industry, and leaves the selection process to industry task forces and an Office of Industrial Reorganization.

To date, Canada's experience with industry task forces has not been encouraging. Admittedly, it is the role of each industry sector to inform the government where its strengths lie. However, all task forces to date have been hampered by a lack of assurance on the continuity of goals. Major programs are needed to fill this gap.

In our use of the term, innovation "means a conscious sequence of events, covering the whole process of creating and offering goods or services that are either new, or better or cheaper than those previously available". This definition acknowledges that engineering design, production engineering, market research, marketing and many other activities can, in many cases, prove more important - and more expensive - than R & D.

In contrast, the Senate Committee appears to be concerned almost exclusively with new products emerging from greatly enlarged research laboratories. Its recommendations deal with these laboratories: their budgets, their internal management, and how government can best assist them. None of its recommendations refer to any other links in the innovation chain. If this is the intent of the Senate Committee, then it would represent a serious oversight; if, however, the Senators' remarks are interpreted as applying to "innovation" and not just to R & D, the views they express become significantly closer to those of the Science Council.

Also in Report No. 15 the Science Council noted "there is...little point in doing industrial research simply for its own sake. There are many ways in which a company can achieve technological proficiency, and R & D is one of the means to this end". As others have observed, the present low level of industrial R & D is not the cause of our innovative shortcomings; it is simply a symptom of larger problems.

The Senate Committee tends to use the term "industrial R & D" and "innovation" almost interchangeably. Of its 26 specific recommendations dealing with the industrial sector, 13 are concerned with the organization, funding, or management of industrial R & D. If this is intentional, then we believe it is an undue emphasis on one aspect of the innovative process, and is likely to perpetuate a fallacious belief in a far-from-direct cause-and-effect relationship.

The targets proposed for industrial R & D expenditures are that these should account for some 60% of a Gross Expenditure on R & D projected to be equal to 2.5% of GNP by 1980. These would undoubtedly transgress a fundamental rule: no company should spend more on R & D - or, indeed, on any other innovative activity - than it is likely to find profitable. The targets, when coupled as they are with a proviso that the federal share of funding the activity will remain unchanged, are in any case totally unrealistic. They imply an additional annual R & D funding by industry of \$2 billion by 1980. At a research intensity of 1.2% of sales - the current level in R & D-performing companies in Canada - this presupposes a sales increase of \$170 billion. At 4% of sales - the U.S. intensity - \$50 billion additional sales are needed. Neither is likely: the whole of Canada's GNP in this period is forecast to increase by only \$100 billion, and in 1970 sales of manufactured goods accounted for only about 25% of GNP.

There is unquestionably a need to increase Canada's overall expenditures on industrial innovation and the real growth rate proposed by the Committee - 16 per cent per year - may not be unrealistic. But it is important

to keep the component activities in proportion - and some of the other components need to be strengthened at least as much as R & D.

At the same time, both the Senate Committee and the Science Council recognize that this exercise will be fruitless unless the external impediments to innovation - limited market access world-wide, barriers to international trade, fragmentation, the market allocation policies of multinational corporations - are lessened.

We wholeheartedly support the Senate Committee in its concern for manufacturing industry. Its analysis of the problems this sector faces closely parallels our own (in Report No. 15): fragmentation, improper location, shortage of well-managed venture capital, and conflicting federal governmental policies, among others. (Their report tends to underplay the significance of the impact of provincial government policies on innovation; a coordinated federal policy is meaningless without provincial support. The Science Council will shortly publish a background study "Governments and Innovation" which comments on this topic.)

The Science Council has traditionally placed greater stress on the resource-based industries in this country than is accorded to them by the Senate Committee. This sector is still an important one, accounting for 10 per cent of our total industrial production. A review of policy issues in the resource field will soon be published by the Science Council which seeks to outline some of the difficult decisions which need to be made in this area.

In recent years the Science Council has acquired a growing awareness of the important role of the service sector of our economy, but it appears that the Senate Committee's evaluation of that sector differs from ours. They state that "the country cannot expect to base its long-term growth strategy on services as prime movers"; we could ask why not? We feel that the current state of understanding of the role of the service industries is insufficient to permit one to make categorical statements either way. This sector already employs more Canadians than manufacturing, (all services, public and private, employ about 60% of the labour force) and its rate of growth is far larger. Its record of productivity gains is extremely disappointing, however; this derives in very large measure from its slow rate of technological change. It is, in short, a field for which innovation is even more important than for manufacturing.

Perhaps the time has come to take a fresh look at what the service sector of our economy really is and does; to ask how valid is our traditional concept that regards services as a component of economic activity that comes after production and that is ancillary to production. We must ask if production per se is a primary goal. On such a conceptual base it is hard to reconcile the fact that manufacturing, in an advanced economy, is a dwindling proportion of the GNP and of the labour force. However our whole concept of the relationship of services to production could be reversed, and the provision of services or servicing of needs could be taken as the primary objective, with material production as the necessary but ancillary activity. In such a

new framework, the goals of technology and of science policy may be seen in a new light and the conventional attitudes, developed under conditions of low technology and of widespread material scarcities, may greatly change.

In neglecting the service sector, the Senate Committee distorts the role of our post-secondary educational institutions. While we believe university courses should take more account of industrial needs than they do at the moment, it is a mistake to orient them simply to provide training for R & D in manufacturing. The function of higher education extends far beyond the role of training. Even within the training role, it should be recognized that many other innovation activities in manufacturing need to be strengthened. More important, other sectors of our society need innovation just as badly in this decade.

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SUMMATION

The foregoing analysis has shown that there are substantial differences between the views of the Science Council and those of the Senate Committee on issues which provide the essential framework for national science policy; it is therefore to be expected that our conclusions on detailed matters of government organization also differ. For example the Council's published opinion on "Policy for Scientific and Technical Information Dissemination" (Report No. 6) and the Council Chairman's proposals on the subject of the study of the future, (in the Council's Fifth Annual Report) represent a different approach from that recommended by the Senate Committee. These opinions were neither referred to in Volume 2 of the Committee's Report nor alluded to in subsequent speeches by members of the Committee.

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It is our hope that this presentation of two different options, based on perceptions of science and of science policy from two different vantage points, will be a positive contribution to the understanding of the issues involved in the formulation of national science policy for Canada

As we noted earlier, Canada's science policy has been debated for the last six years, and the volume of published advice has grown steadily. It is reassuring to see the beginnings of some convergence and consensus in the advice being proffered. The Senate Committee's Report indicates that they agree with a variety of the published recommendations of the Science Council on matters of general policy. We hope that this discussion of our remaining differences of opinion will lead to a further extension of the areas of agreement.

